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Materials Development: Pitfalls, Successes, and Lessons

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The incorporation of new or improved materials in aerospace systems, or indeed any systems, can yield tremendous payoffs in the system performance or cost, and in many cases can be enabling for a mission or concept. However, the availability of new materials requires advance development, and too often this is neglected or postponed, leaving a project or mission with little choice. In too many cases, the immediate reaction is to use what was used before; this usually turns out not to be possible and results in large sums of money, and amounts of time, being expended on reinvention rather than development of a material with extended capabilities.

Material innovation and development is time consuming, with some common wisdom claiming that the timeline is at least 20 years. This time expands considerably when development is stopped and restarted, or knowledge is lost. Down selection of materials is necessary, especially as the Technical Readiness Level (TRL) increases. However, the costs must be considered and approaches should be taken to retain knowledge and allow for restarting the development process. Regardless of the exact time required, it is clear that it is necessary to have materials, at all stages of development, in a research and development pipeline and available for maturation as required.

This talk will discuss some of theses issues, including some of the elements for a development path for materials. Some history of materials developments will be included. The usefulness of computational materials science, as a route to decreasing material development time, will be an important element of this discussion. Collaboration with outside institutions and nations is also critical for innovation, but raises the issues of intellectual property and protections, and national security (ITAR rules, for example).

The talk will focus on structural and thermal protection materials, but the lessons and guidelines will be broadly applicable to most materials.